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Proposed Farm Information Management System Design and Database Management for Recommendation Fertilizer and Financial Record Feature

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ABSTRACT: This study proposes a comprehensive Farm Information Management System (FIMS) design and database management strategy for addressing the specific requirements of Indonesian agriculture, with a particular emphasis on fertilizer recommendation and financial record management. The study employs the Software Development Life Cycle (SDLC) methodology as a framework for directing the system's design, development, and implementation. The goal of the FIMS is to provide producers with a user-friendly interface to access accurate fertilizer recommendations based on crop-specific requirements and local soil conditions. Additionally, the system includes a robust financial record function to aid producers in effectively managing their income, expenses, and investments. The proposed SDLC-based approach assures a structured and methodical development process, including requirements analysis, system design, implementation, testing, and maintenance. Using the SDLC methodology, this study seeks to develop a scalable, secure, and interoperable FIMS that can be effectively integrated into Indonesia's existing agricultural infrastructure. The effectiveness and usability of the proposed system will be determined through extensive testing and evaluation to ensure its suitability and functionality in actual agricultural contexts. Ultimately, the proposed Farm Information Management System, developed using the SDLC method, aims to empower Indonesian farmers with optimized fertilizer recommendations and streamlined financial record management, thereby contributing to sustainable agriculture practices, and enhanced economic incomes for the nations.

KEYWORDS: Fertilizer Recommendation, Financial Record, Farm Information Management System, Software Development Life-Cycle

INTRODUCTION

Indonesia is predominantly an agricultural nation, where a significant majority of the population earns around 40% of their income from agriculture [1]. The country's fertile mountain ranges contribute to its agricultural potential. Agriculture has played a crucial role in Indonesia's economy, contributing to employment and GDP growth. According to data from BPS, the agricultural production index increased by 1.61 points in 2021 compared to the previous year, driven by growth in food crops, horticulture, and plantations. However, the agricultural sector faces challenges such as low productivity, outdated farming practices, limited technology access, and the impacts of climate change. Efforts are being made to address these challenges and promote sustainable agriculture through government initiatives and other organizations. Agriculture in Indonesia faces numerous challenges that hinder its growth and progress, including a decline in its contribution to GDP in 2021 compared to the previous year. One of the major obstacles is low productivity, resulting from outdated farming practices and limited access to technology. Smallholder farmers, who form the majority of the sector, often lack the means to access modern agricultural inputs and technologies, which limits their capacity to increase yields and improve their income. Agriculture in Indonesia faces challenges that hinder its growth, including low productivity due to outdated practices and limited access to technology. The removal of fertilizer subsidies negatively impacts farmers' income and reduces their ability to increase yields [2]. To address these issues, businesses are developing a dashboard platform that provides farmers with crucial information about their land, enhancing productivity and income. Another challenge is low investment in agriculture due to poor productivity and uncertain raw material availability [3]. These issues are exacerbated by the high cost of fertilizer, further reducing farmers' income.

BUSINESS ISSUES

Based from the interview with several farmers. the revocation of fertilizer subsidies has caused significant harm to farmers, as they now have to allocate more funds for production. Several solutions have been introduced, such as soil condition sensors, weather

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monitoring tools, and data dashboards, which initially seemed promising. However, farmers still face unresolved issues. They lack guidance on choosing the right fertilizers based on soil conditions, leading to suboptimal results. Fluctuating fertilizer prices and unpredictable weather further contribute to uncertain monthly incomes. Additionally, farmers struggle to attract investors due to inadequate income and expense records. Lack of awareness about technological advancements also hinders farmers from adopting new solutions to address their challenges.

METHODOLOGY

The Software Development Life Cycle (SDLC) is a process of building or maintaining software systems. Typically, it includes various phases from preliminary development analysis to post-development software testing and evaluation [4]. There are many opinions regarding the number of phases in SDLC, according to Kendall & Kendall [5], the phases in SDLC are divided into seven parts, namely:

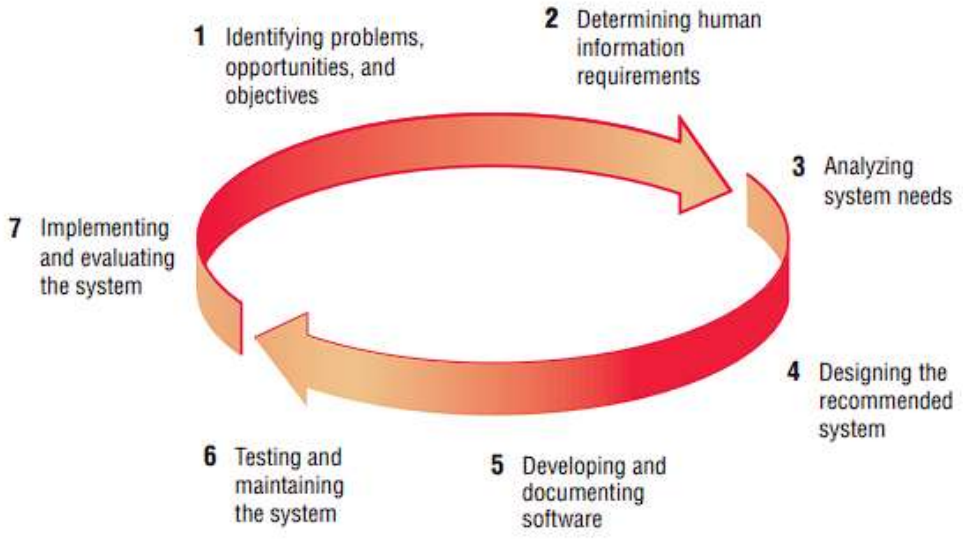

Figure 1. Seven Phases of SDLC (Source: Kendall & Kendall, 2011)

In this research, the authors will only use the first four stages of SDLC.

RESULT AND DISCUSSION

A. Identifying Problems, Opportunities, and Objectives

In the first stage, problem identification was carried out by conducting interviews with the farmers. This interview was conducted to determine the root cause of which the results are as follows.

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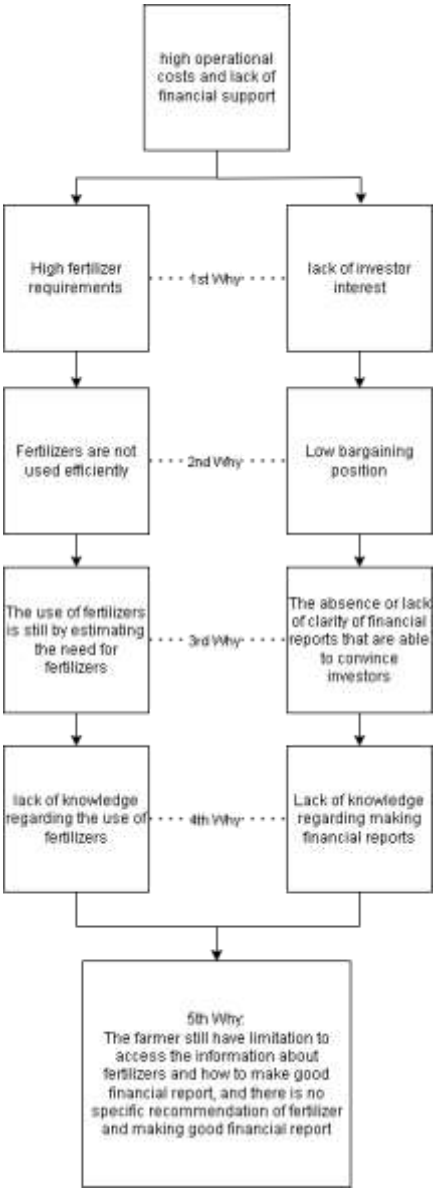

Figure 2. Root Cause Analysis (source: Author, 2023)

Based on the result above, it can be seen farmers need an information system that can give farmer information about recommended fertilizer and financial record. So, the feature will be developed in an application called FarmApp.

B. Determining Human Information Requirements

1) Proposed Solution

The second step carried out according to the SDLC method is determining human information requirements. After knowing that the root of the problem lies in the difficulty of finding fertilizer at low prices and the lack of efficiency in its use and the difficulty of finding investors to invest their funds in agricultural land, the solutions made are:

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Table 1. Proposed Solution (source: Author, 2023)

Factor	Problems	Solution
Farmers	Difficulties in understanding and implementing existing technological developments. Lack of understanding of technology causes businesses to run inefficiently.	Conduct counseling regarding the use and utilization of renewable technology that can help farmers to more easily keep up with the times.
Fertilizer	The removal of fertilizer subsidies made it difficult to find low-priced fertilizers, which made it even more difficult for farmers to compete in the agricultural business and not get maximum profits.	Providing the right information to farmers by creating a system that is able to provide information about fertilizer recommendations and their use
Financial Record	The absence of periodic records makes investors less interested in putting their money in the agricultural business sector.	Creating a system that can record monthly fund transactions and visualize it so that it is easy for both farmers and investors to understand

C. Analyzing System Needs

1) Decomposition Business Process

After the business process is identified, the business process will be decomposed into a more detailed process before creating a data flow diagram. Process decomposition is done by defining the function into a more detailed process and sub-process. The table below defines the decomposition processes of the FarmApp proposed feature.

Table 2. Decomposition Business Process (Author, 2023)

Process		
Planting Phase	**Fertilizer Recommendation and Financial Record**	**1. Log in to FarmApp**
		1.1 Register account
		1.1.1. Input username
		1.1.2. Input email
		1.1.3. Input password
		1.2 Log in account
		1.2.1. Input Username
		1.2.2. Input Password
		2. Input General Information that Needed by Feature
		2.1. Input name
		2.2. Input address
		2.3. Input land name
		2.4. Input land area
		3. Soil Sensor Installation
		3.1 Request soil sensor installation
		3.2. Rquest received and negotiate price
		3.3. Agreement reached for soil sensor instalation

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			3.4 Soil sensor installation	
			3.5. Soil sensor gathering data	
		4. Fertilizer Recommendation		
			4.1 Make Fertilizer Recommendation	
				4.1.1. Farmer input commodities data
				4.1.2 Received NPK and pH data
				4.1.3. Analyze data
				4.1.4. Match dthe data with fertilizer composition
			4.2. Give Fertilizer Recommendation	
		5.1. Analyze Financial Performance		
			5.1. Record income/expense	
			5.2. Analyze income and expense data	
			5.3. Visualize analysis result	
		6. Financial Record		
			6.1. Receive visualization result	
			6.2. Giving visualization	

2) Decomposition Business Process

After creating the table above, the next step is the context diagram of the system that is created. Context diagrams are made to create a clear picture of each entity needed to run the feature along with how the relationship between each entity and the features that are carried.

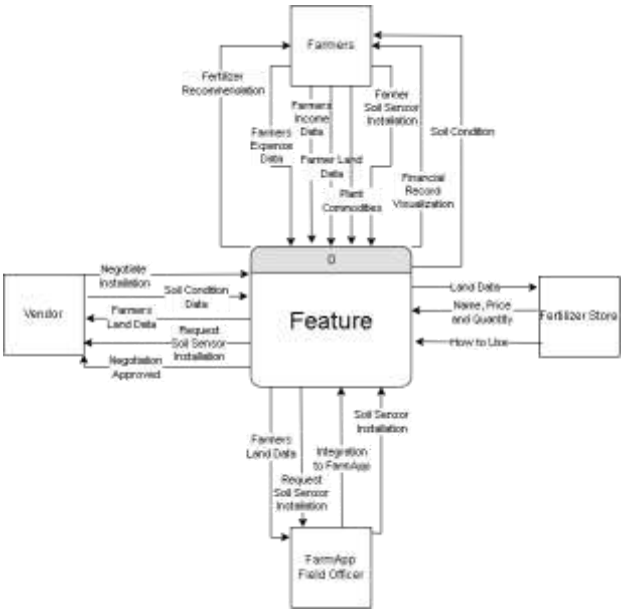

Figure 4. Context Diagram (Author, 2023)

3) Data Flow Diagram

Based on figure 2, there are four related entities to use existing features, namely farmers, vendors, FarmApp field officers, and fertilizer stores. Each entity plays an important role in carrying out the features that are carried. After creating a context diagram, the next step is to create a level 0 data flow diagram.

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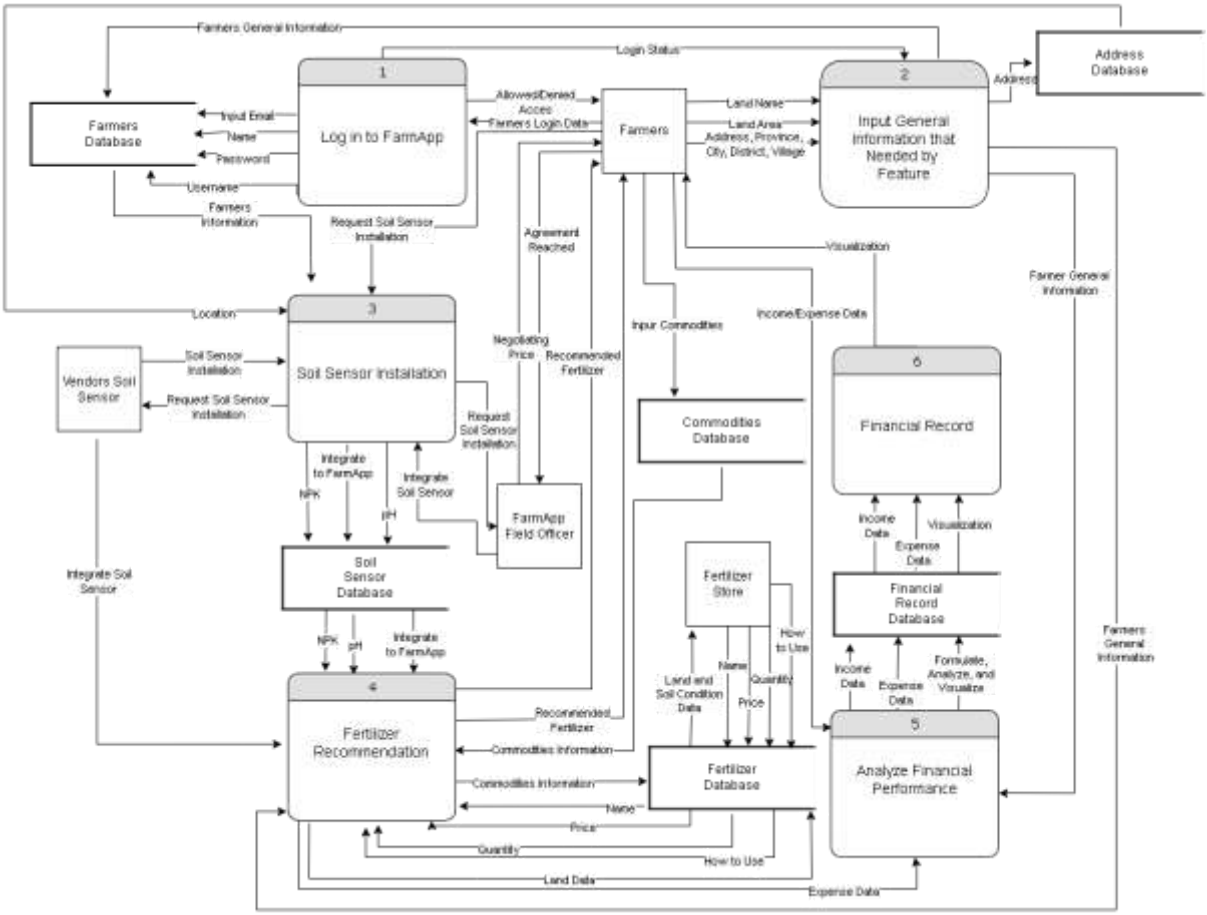

Figure 5. Data Flow Diagram Level 0 (Author, 2023)

The figure above shows level 0 of the data flow diagram for the features you want to develop. The drawing is made to show the flow and relationship of each process. As shown in the decomposition process table, there are six main processes to carry out the features developed. For the next data flow diagram, it will describe the flow of each entity, input data, and processes that are interconnected in more detail.

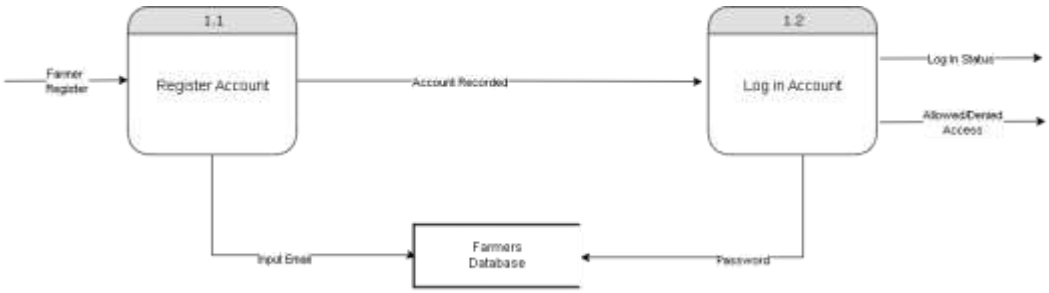

Figure 6. Data Flow Diagram Level 1 Log in to FarmApp (source: Author)

In the first stage, the process begins with the registration stage to FarmApp which will be carried out by farmers. The application will grant permission or deny access to the application. After the farmer has successfully registered with the application, the farmer can log in to FarmApp.

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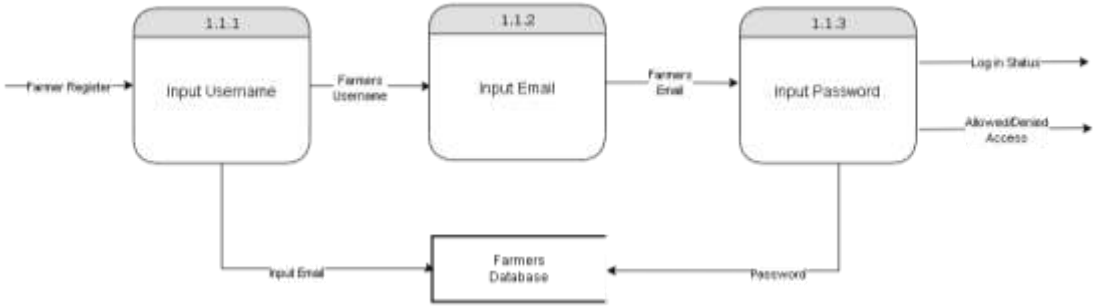

Figure 7. Data Flow Diagram Level 2 Register Account (source: Author)

Figure 8. Data Flow Diagram Level 2 Log in Account (source: Author)

At the registration stage, farmers must input some of the data needed to register with the application, namely email, username, and password, and the data will enter the database. After inputting the required data, farmers can log in to FarmApp.

Figure 9. Data Flow Diagram Level 1 Input General Information that Needed by Feature (source: Authir)

After farmers have successfully logged in to the application, farmers are required to fill in data regarding their land. The data is intended to help FarmApp to identify basic information about farmers starting from the farmer's name, land address, land name, and the area of land owned.

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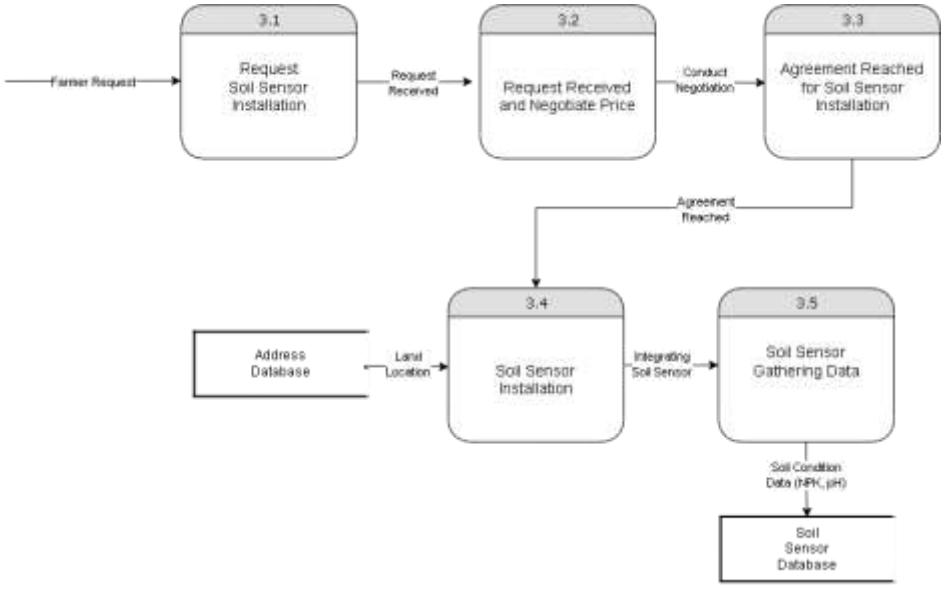

Figure 10. Data Flow Diagram Level 1 Soil Sensor Installation (source: Author)

In order to use the "Fertilizer Recommendation" feature, farmers are required to submit a request for the installation of a soil sensor. This is so that the soil sensor can access soil conditions on the land and provide the best recommendations for farmers. After making the submission, the soil sensor vendor will come to the farmer to negotiate the price and type of payment regarding the installation of the soil sensor. After the agreement is reached, the soil sensor vendor and FarmApp field officer will come to the site to install the tool and integrate it into the application.

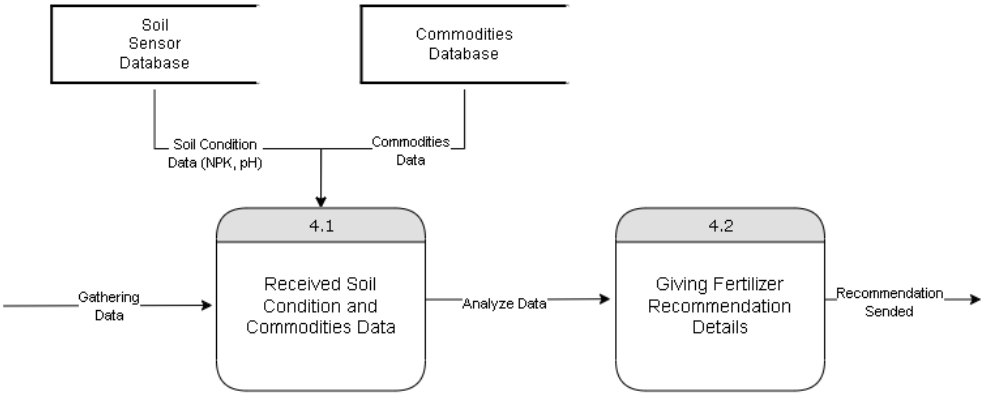

Figure 11. Data Flow Diagram Level 1 Fertilizer Recommendation (source: Author)

After the tool is installed, farmers get access to the fertilizer recommendation feature. Farmers are required to scan the condition of the land so that the soil sensor can read soil conditions. Farmers are also required to enter the commodity that is being planted. After the application has successfully scanned all the information, fertilizer recommendations will be obtained.

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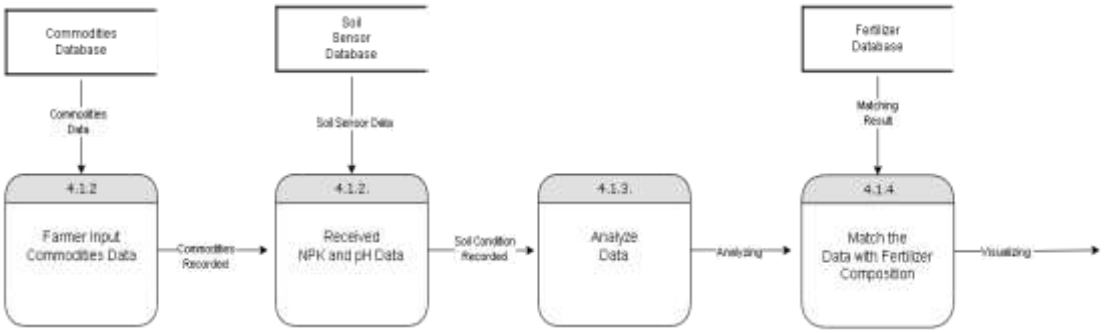

Figure 12. Data Flow Diagram Level 2 Make Fertilizer Recommendation (source: Author)

Fertilizer recommendations are obtained from data on soil conditions, namely NPK levels, pH, and existing commodities. The collected data will be processed by the application. The application also retrieves fertilizer data obtained from research results at fertilizer shops that are most suitable for the soil conditions in the field. After all the analysis has been collected, farmers can see the most appropriate fertilizer recommendations for the soil conditions and the commodities being planted.

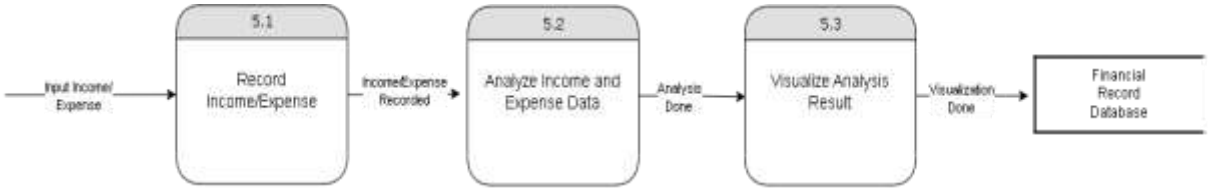

Figure 13. Data Flow Diagram Level 1 Analyze Financial Performance (source: Author)

Farmers can also access the financial record feature provided in the FarmApp application by first filling in the general information required by the application. The application will ask the farmer to input data regarding income and expense from each activity carried out. The application will collect data and then analyze the data and draw conclusions from the data.

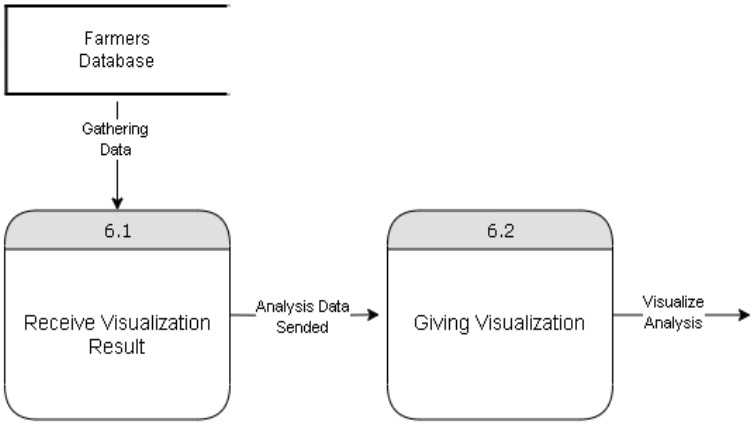

Figure 14. Data Flow Diagram Level 1 Financial Record (source: Authir)

At this stage, the application will receive the results of the analysis from the previous stage, after which the application will create visualizations that are easy for farmers to understand, this is intended to help make it easier for farmers to read the data. Farmers can also export data to excel so that the data can be shown easily to investors so that they can help get funding.

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4) Entity Relationship Diagram

At this stage, the application will receive the results of the analysis from the previous stage, after which the application will create visualizations that are easy for farmers to understand, this is intended to help make it easier for farmers to read the data. Farmers can also export data to excel so that the data can be shown easily to investors so that they can help get funding After the data flow diagram is made, the next step is to look at a set of datasets that need to be created to collect data so that a database design is needed to use existing features. So, the next step is to make an entity-relationship diagram (ERD). ERD is a diagram that is used to design databases and shows each relationship between entities in detail. To design a database, the first thing to do is to know each entity that exists. After determining the entities from each existing dataset, then determine the attributes needed by each entity. This attribute serves to explain and find out what data is needed for each entity. Here are some examples of the entities for each attribute and the rest can be seen in the appendix.

Table 3. Database Attribute

Farmer
Farmer ID
Request ID
Farmers Address ID
Username
Financial ID
Farmers Income
Farmers Expense
Recommendation ID
Commodities Name
Name

(source: Author, 2023)

Then the next stage is to create an ERD to see the relationship of each dataset and determine the primary key, foreign key, and non-attribute key of each attribute for each entity.

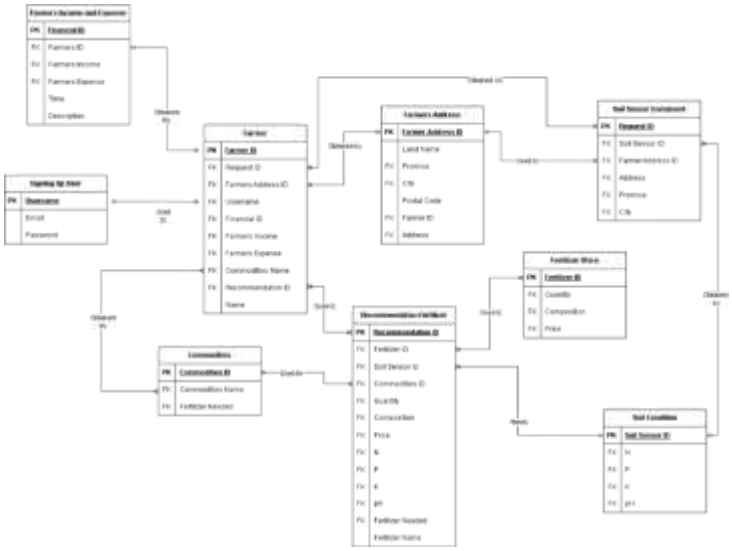

Figure 15. Entities Relationship Diagram (source: Author, 2023)

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Based on the results of the analysis, here are some examples of a database table that has been normalized.

Table 4. Normalization Data (source: Author, 2023)

Farmer	1NF	2NF	3NF
Farmer ID	V	V	V
Request ID			
Farmers Address ID			
Username			
Financial ID			
Farmers Income			
Farmers Expense			
Recommendation ID			
Commodities Name			
Name			

D. Designing the Recommended System

In accordance with the SDLC stages, the final step is designing the recommended system. At this stage, the visual user interface results of the features developed will be displayed. In the picture below are some illustrations of the results of the user interface design which are intended for the two features being developed, namely fertilizer recommendation and financial record. The rest of the user interface design can be seen in the appendix.

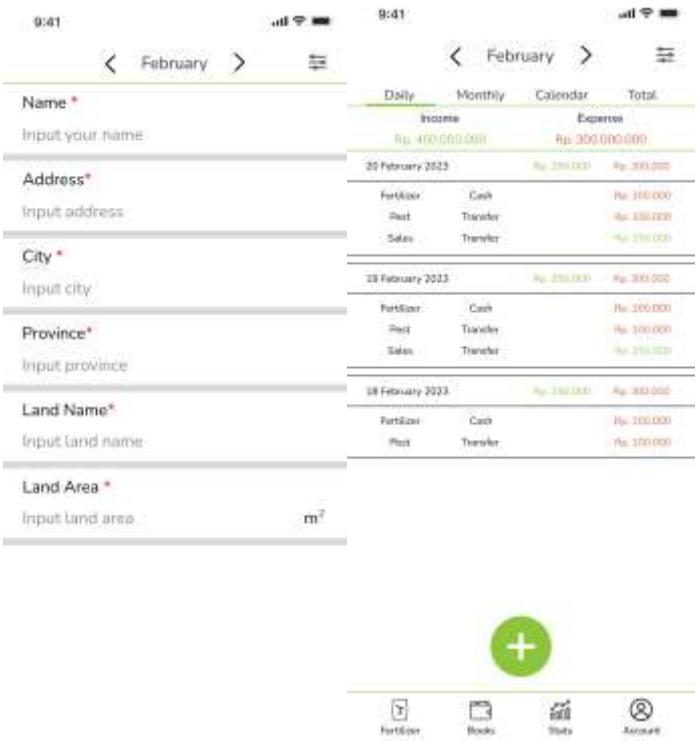

Figure 16. FarmApp Feature User Interface (source: Author, 2023)

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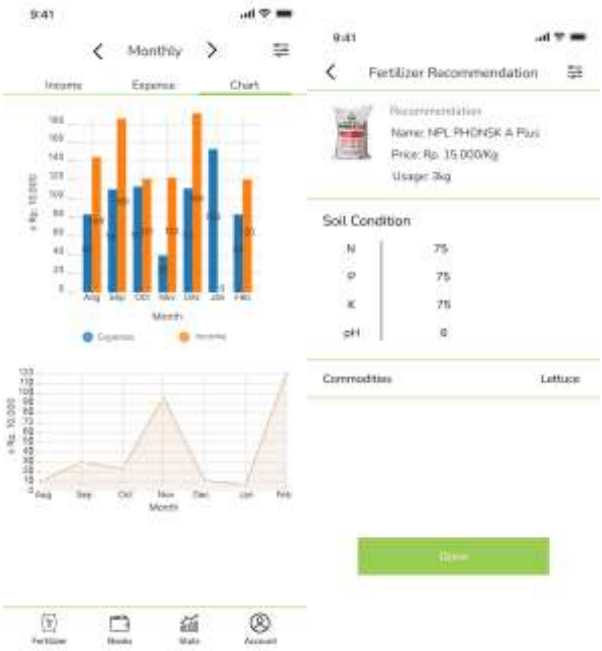

CONCLUSION

From the results of the analysis conducted, it can be concluded that farmers need access to information about fertilizers and make good financial records. This is due to the lack of information obtained by farmers so that agricultural processing becomes less efficient. Therefore, the FarmApp application offers a solution in the form of features that can answer the problem regarding the lack of information about fertilizer and financial records by providing features in the form of fertilizer recommendations and financial records.

In developing this feature, research was conducted to find out what information farmers need. After that, development is carried out by making information flows and determining each entity needed to run the information system that is made. The next step is to create a data flow diagram that is able to see the flow of each data which can help clarify where the data is coming from and where it will be directed. Then, create a database by specifying each attribute, primary key, foreign key, and non-attribute key, and creating a relationship between each database. After that, make an application design that can be accessed by farmers with an easy user interface so that farmers have no difficulty or are reluctant to adopt new technology.

This feature can be accessed through the FarmApp application by filling in your personal data and information about your agricultural land. For the fertilizer recommendation feature, FarmApp must collaborate with soil sensor vendors, fertilizer stores, and integrate into the application so that it can display the right recommendations for farmers.

The financial record feature can also be accessed in the FarmApp application by simply inputting the details of income and expense. The data is then processed by the FarmApp application and visualized so that the data is easier to understand. Data can also be exported in excel form so that it can make it easier for farmers to provide the data to investors so that investment can be more easily obtained.

RECOMMENDATION

A. Theoretical Implication

This research has several limitations, including this research is only carried out according to the needs of farmers in West Java which may not be relevant for other regions. This research was also only carried out for the FarmApp application where all research results were matched with FarmApp. This research only discusses how the description of the fertilizer recommendation feature and financial record is made so that it does not match the other features. This feature also only answers up to the fourth stage of the SDLC method and has limitations according to the business scope.

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B. Business Implication

After successfully creating features that can help farmers. The next step is to socialize with farmers. This is done to provide information to farmers that there are features that can help them run their business.

C. For Future Research

The recommendations given for future research are to continue this research until the final stages of the SDLC method and to carry out further research on existing features. Carrying out development in the field of database and application design so that it will always be relevant to technological developments and is increasingly able to facilitate FarmApp applications.

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